The Blast Wave parameterization as a tool to characterize flow

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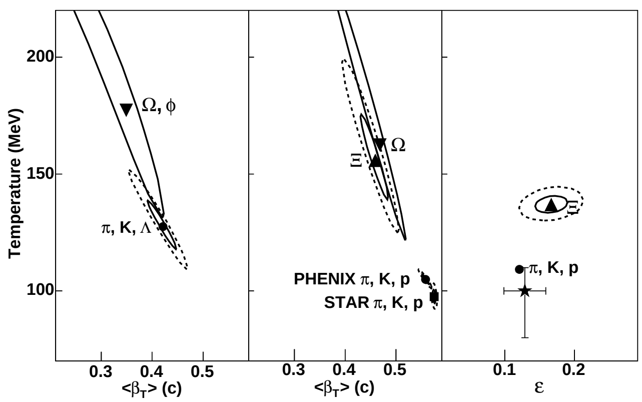

FIG. 1: Blast Wave fit contours. Plain (dash) lines: 1 (2) σ contour. Points: best fit parameter.

Au-Au collisions at RHIC produce a medium whose density appears to be large enough to absorb a significant amount of energy from fast partons and initiate a large collective expansion. Flow builds up over the whole evolution of the system possibly going through two distinct stages, one partonic and one hadronic. A wide variety of observables are sensitive to flow but they probe the final state of the system and its evolution needs to be inferred from models. Before describing the system evolution it is mandatory to tie up these observables together within models or parameterizations.

Hydrodynamic models are well suited to study flow in the limit where the mean free path is small. They are successful at reproducing transverse momentum spectra and elliptic flow but they fail at describing the pion source size. On the other hand, we showed in [1] that the Blast Wave parameterization does reproduce simultaneously these three different observables as well as the space-time separation between pion and kaon sources[2]. Thus, the data can be described within a self-consistent picture.

Fitting the Blast Wave parameterization to transverse mass spectra and elliptic flow provide the following parameters: temperature, flow velocity, flow velocity azimuthal modulation and system eccentricity. The eccentricity quantifies the spatial shape of the system at freeze-out. It is equal to zero when the system is azimuthally symmetric, positive (negative) when the system is extended out-of-plane (in-plane). As the initial Au-Au collisions yield an out-of-plane extended system, a large eccentricity implies earlier freeze-out than a small, possibly negative, one. Figure 1 shows the parameters extracted fit to Ξ data and a combination of pion, kaon and proton data. We find that Ξ freeze-out temperature and eccentricity is larger than π, K, p, while its flow velocity is smaller, suggesting that Ξ freeze-out earlier than π, K, p.

We also investigate the system spatial expansion within the same framework as shown in figure 2. We find a very nice scaling of the spatial expansion with the spatial density gradient when varying the centrality and the azimuthal angle at which expansion is evaluated. As expected the system expands more in-plane where the gradients are the strongest than out-of-plane. Thus there appears to be a direct correlation between the flow driving spatial density gradients and the system spatial expansion.

We have developed the Blast Wave parameterization into a tool that can be used to characterize flow quantitatively, which has proved useful in assessing differences in flow pattern between different particle species and in relating the amount of flow (or spatial expansion) to the initial state of the system.

[1] F. Retière and M. Lisa, Submitted to Phys. Rev. C (2003).
[2] J. Adams et al., Phys. Rev. Lett. **91**, 262302 (2003).

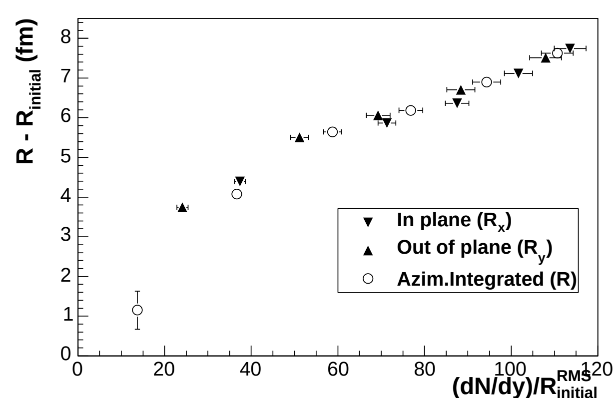

FIG. 2: X axis = estimate of the initial spatial density gradient, which transate into pressure gradients when particle re-interact.Y axis = difference between the radius of system edge at freeze-out (from Blast Wave fit) with the initial radius of the system (from Glauber calculation).